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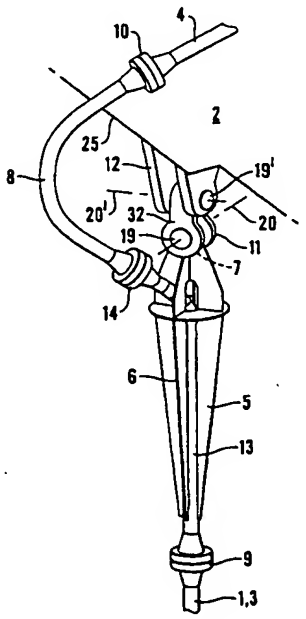
(54) Title: SUSPENSION DEVICE FOR A RISER



(57) Abstract: The invention relates to a suspension device for a riser (1), for connecting the riser (1) to piping (4) on a fixed or floating structure (2). The suspension device comprises a body (5) with a hanger attachment (7), an essentially flexible jumper hose (8) extending from a riser end connection (9) to a piping connection (10) on the fixed or floating structure (2), and an essentially moment-free hanger (11) extending from the body's hanger attachment (7) to a hanger attachment (12) on the fixed or floating structure (2). The suspension device may also comprise an intermediate pipe (13) between the riser end connection (9) and the jumper hose (8).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Suspension device for a riser

The invention relates to a suspension device for a riser, for connecting the riser to piping on a fixed or floating structure.

When producing hydrocarbons from offshore subsea reservoir wells, the hydrocarbons are normally transported from the well, a subsea process facility or a subsea manifold located on the sea floor to a fixed or floating structure in risers, which are stiff, flexible or semi-flexible pipes, and which are suspended from the fixed or floating structure. The fixed or floating structure may be a platform fixed to the sea floor, a floating platform, a fixed or floating storage tank, a submerged or floating buoy or a ship. At the fixed or floating structure the hydrocarbons flow from the risers into piping, which may comprise process equipment, and further into storage facilities, for a later transport away from the offshore location. Risers may also form parts of lines for transporting hydrocarbons between fixed or floating structures, e.g. between a fixed production platform with process facilities and a floating storage buoy, or between a storage buoy and a tanker.

A fixed structure is part of a substructure standing on the sea floor, while a floating structure is anchored to the sea floor or is kept in place by thrusters controlled by a dynamic positioning system. Wind, waves, tide and sea currents generate motions both to the fixed or floating structure and the risers, which cause relative movement between the fixed or floating structure and the risers. If no precautions are made, this relative movement induces bending moments and torque in the upper end of the risers, i.e. the area in which the riser is suspended from the fixed or floating structure. These bending moments and torque may cause unacceptable stresses in the suspension area of the risers, which may cause a hydrocarbon leakage or harm the risers. It is therefore important to design the connection between the riser and the fixed or floating structure in such a way that excessive stresses do not occur. Risers are normally detachable, i.e. the connection between the fixed or floating structure and the riser is formed by a mechanically actuated quick-release coupling, which may be released if the relative movements between the riser and the fixed or floating structure are too big. Detaching the risers does, however, stop the hydrocarbon production, and consequently this is no acceptable way of overcoming the problem.

Fixed or floating structures may also be used for fluid injection in a reservoir, in order to maintain the reservoir pressure or deposit undesirable fluids, e.g. carbon dioxide. In this case risers are used to bring the fluids from the fixed or floating structure to an injection well on the sea floor, and the same problem of bending moments and torque in the suspension area of the risers exists.

The problem of bending moments and torque in the suspension area of the risers depend on the type of fixed or floating structure, the type of risers, the length and weight of the risers, the tide and the weather conditions. Obviously a floating structure is more likely to move in the sea than a fixed structure, and thus the problem is bigger for a floating structure, but generally to some extent the problem is always present.

Risers are from time to time pigged, i.e. a pig, which is a device with a diameter which is smaller than the internal diameter of the riser, is sent through the riser. Preferably a solution to the problem of bending moments and torque in the suspension area of the riser should allow pigging.

One way of overcoming the problem of bending moments and torque in the suspension area of the riser is to provide the upper part of the riser with an outer, stiff guide pipe which withstands the bending moments and the torque. The entrance to the guide pipe is trumpet-shaped, which limits the bending of the riser in this area.

Another way of overcoming the problem is to provide the upper end of the riser with an outer bending limiter, which is a flexible pipe which limits the bending of the riser in the suspension area.

EP 811 746 A2 discloses a further way of overcoming the problem. A device for connection or suspension between a detachable flexible or semi-flexible riser pipe and a pipe system on a fixed or floating platform or ship, which riser pipe is designed to transfer oil and/or gas and extends from a connecting point on the sea bed to the platform or ship, is characterized in that the suspension system consists of a rotary connection which is designed in such a way that the connection between the riser pipe and the pipe system is moment-free or mainly moment-free.

The known solutions to the problem of bending moments and torque in the suspension area of the risers function satisfactorily, but are rather expensive.

The object of the invention is to provide a suspension device for a riser which in a cost-efficient way provides a solution to the problem of bending moments in the suspension area of the riser. Preferably the suspension device should also provide a solution to the problem of torque in the suspension area of the riser. A further object is that the suspension device shall allow pigging of the riser.

The objects are achieved by a suspension device for a riser as mentioned in the preamble, which are characterized by the features of the claims.

The invention thus relates to a suspension device for a riser, for connecting the riser to piping on a fixed or floating structure. "Piping" shall be understood as a generic term comprising any component in a fluid system, such as valves, couplings, storage tanks and process equipment.

In a first aspect the suspension device comprises

a body with securing means for the riser end, the riser end being secured by the securing means; and a hanger attachment,

an essentially flexible jumper hose extending from a riser end connection to a piping connection on the fixed or floating structure, and

an essentially moment-free hanger extending from the body's hanger attachment to a hanger attachment on the fixed or floating structure.

In a second aspect the suspension device comprises

an intermediate pipe extending from a riser end connection and having a jumper hose connection,

a body with securing means for the intermediate pipe, the intermediate pipe being secured by the securing means; and a hanger attachment,

an essentially flexible jumper hose extending from the jumper hose connection of the intermediate pipe to a piping connection on the fixed or floating structure, and

an essentially moment-free hanger extending from the body's hanger attachment to a hanger attachment on the fixed or floating structure.

In both aspects the problem of bending moments in the suspension area of the riser is solved by the same inventive idea. According to the invention the riser is suspended from the body, either directly or via the intermediate pipe. The weight of the riser and the body is transferred to the fixed or floating structure via the essentially moment-free hanger. The hanger is designed to transfer tension loads, i.e. longitudinal loads acting in the direction of a notional line between the body's hanger attachment and the hanger attachment of the fixed or floating structure. The hanger is, however, not designed to transfer bending moments of any significance, i.e. the hanger deflects or rotates as a response to loads other than tension loads.

The fluid is transferred between the riser and the piping on the fixed or floating structure via an essentially flexible jumper hose, which is designed to withstand internal pressure and transfer fluids, but which is not designed to transfer loads of any significance. An attempt to apply external loads to the jumper hose will cause the jumper hose to flex in the direction of the load.

A relative motion between the riser and the fixed or floating structure will cause the direction of the load on the hanger due to the weight of the riser to change. The hanger then deflects or rotates into a position in which the weight of the riser pipe and the body is transferred through the hanger as a tension load. The body is fixed to the riser, and thus assumes a new position relative to the fixed or floating structure. The jumper hose is flexible, and adapts to the new position of the body. The jumper hose has a length which is long enough to ensure that no tension acts on the jumper hose from the riser or intermediate pipe respectively, irrespective of the position of the body.

Thus no bending moments are transferred from the body to the fixed or floating structure neither through the hanger nor the jumper hose, and thus no bending moments act on the riser.

Preferably the hanger is also essentially torque-free, i.e. designed to rotate when subjected to a rotational movement around its longitudinal direction, i.e. around a direction defined by the above discussed notional line between the body's hanger attachment and the hanger attachment on the fixed or floating structure. In this way no torque can be transferred from the body to the fixed or floating structure through the hanger, and no torque can act on the riser.

In the description of the specific embodiments the hanger is described as moment-free, i.e. not designed to transfer any bending moments, and torque-free, i.e. not designed to transfer any torque. Similarly the jumper hose is described as flexible, i.e. not designed to transfer any loads. Practically risers can accept some bending moment and torque, and hence embodiments in which the hangers are only essentially moment-free and essentially torque-free, and the jumper hose is only essentially flexible, which may cause some bending moments and torque in the riser, will be acceptable. In order to describe the inventive idea in a clear and concise way and not obscure the description by reservations, a description of such embodiments is left out. It should, however, be understood that the term moment-free includes essentially moment-free, the term torque-free includes essentially torque-free and the term flexible includes essentially flexible.

The invention will now be explained in closer detail with reference to the enclosed drawings, in which:

fig. 1 is a perspective view of a floating platform in the sea,
fig. 2 is a side view of a suspension device according to the invention,
fig. 3 is a side view of another suspension device according to the invention,
fig. 4 is a perspective view of a suspension device according to the invention,
fig. 5 is a perspective view of a further suspension device according to the

invention,
fig. 6 is a perspective view of three suspension devices according to the invention hanging from deck girders of a floating platform,
fig. 7 is a perspective view of 5 suspension devices according to the invention hanging from a subsea buoy,
fig. 8 is a side view of a further suspension device according to the invention, and
fig. 9 is a side view of a further suspension device according to the invention.

Fig. 1 is a perspective view of a floating platform 2 in the sea, comprising a schematically illustrated deck 21 which is supported by shafts 23 extending through the sea surface 22 to pontoons 24. The platform 2 receives hydrocarbons from subsea reservoir wells on the sea floor, which hydrocarbons are transported to the platform 2 through risers 1, which are suspended from the platform. At the platform 2 the hydrocarbons flow from the risers 1 into piping 4 located on the deck 21. The piping 4 comprises not illustrated process equipment to separate the hydrocarbons into gas, condensate and oil, which are stored in adequate storage facilities, for a later transport away from the platform 2 by a tanker.

The floating platform 2 is kept in place by not illustrated thrusters controlled by a dynamic positioning system. Wind, waves, tide and sea currents generate motions both to the platform and the risers, which cause relative movement between the platform and the risers. The risers 1 are stiff, and if no precautions are made, this relative movement generates bending moments and torque in the upper end of the risers, i.e. the area in which the risers are suspended from the platform 2. These bending moments and torque may cause unacceptable stresses in the suspension area of the risers, which may cause a hydrocarbon leakage or harm the risers. To overcome this problem, the risers 1 are suspended from the platform 2 by suspension devices according to the invention.

Fig. 2 illustrates a first embodiment of a suspension device according to the invention, for connecting the riser 1 to piping 4 on the platform 2. The suspension device comprises a body 5 with securing means 6 for the riser end 3. The riser end 3 is the upper portion of the riser, and has a length which is not strictly defined, but which may be between 1 and 5 metres, typically 2 metres. The securing means 6 are formed by transverse support plates which are welded to the body 5 and the riser end 3, which is made of steel. The riser 1 is provided with an end connection 9, formed by a pipe flange. A flexible jumper hose 8 extends from the riser end connection 9 to a piping connection 10 on the platform 2, see fig. 1.

Further the body 5 of the suspension device of fig. 2 is provided with a hanger attachment 7 formed by an eye through the body 5, for a moment-free hanger

extending to a hanger attachment on the platform 2, which will be discussed in more detail later.

Fig. 3 illustrates another embodiment of a suspension device according to the invention. This suspension device also comprises a body 5 with a hanger attachment 7 for a moment-free hanger extending to a hanger attachment on the platform 2. In this embodiment, however, the riser end connection 9 is connected to an intermediate pipe 13, which is secured to the body 5 by securing means 6 formed by longitudinal support plates which are welded to the body 5 and the intermediate pipe 13. The end of the intermediate pipe 13 opposite the riser end connection 9 is provided with a jumper hose connection 14 for a flexible jumper hose 8 extending to a piping connection 10 on the platform 2, see fig. 1.

Thus fig. 2 illustrates a suspension device in which the riser 1 is directly secured to the body 5, while fig. 3 illustrates a suspension device in which the riser 1 is secured to the body 5 via the intermediate pipe 13, and the securing forces are transferred to the riser 1 through the riser end connection 9.

Fig. 4 is a perspective view of the suspension device in fig. 3. In fig. 4 the suspension device is suspended from the platform 2 by a hanger 11 extending from the body's hanger attachment 7 to a hanger attachment 12 on the platform 2. The hanger attachment 12 is formed by two lugs which are welded to a girder 25 which supports the deck 21 of the platform 2, see fig 1. A bolt 19' forming a pivot joint extend through eyes of the two lugs in an axis 20'. A link 32 supported by the bolt 19' in turn supports another bolt 19 extending through the eye 7 of the body 5 in an axis 20, forming another pivot joint. The two axes 20 and 20' are perpendicular to each other, and the bolts 19, 19' and the link 32 thus form a moment-free hanger 11, i.e. bending motion applied to the hanger 11 will cause a rotation in one or both pivot joints 19, 19', and not cause any moments.

The weight of the riser 1 and the body 5 is transferred through the hanger 11 as a tension load, i.e. a longitudinal load acting in the direction of a notional line between the body's 5 hanger attachment 7 and the platform's hanger attachment 12.

The riser 1 is fixed to the body 5, and thus a relative motion between the riser 1 and the platform 2 will cause the direction of the load on the hanger 11 due to the weight of the riser 1 to change. This causes one or both pivot joints 19, 19' to rotate into a position in which the load from the weight of the riser 1, and also the weight of the body 5, again will be a tension load.

The fluid is transferred from the intermediate pipe 13 to the piping connection 10 of the piping 4 on the platform 2 via the jumper hose 8. The jumper hose is

designed to withstand internal pressure and transfer fluids, but it is not designed to transfer loads. An attempt to apply external loads to the jumper hose 8 will cause the jumper hose to flex in the direction of the load. A relative motion between the body 5 and the platform 2, i.e. a relative motion between the riser 1 and the platform 2, thus causes the jumper hose 8 to adapt to the new position of the body 5. The jumper hose 8 has a length which is so adapted that no tension acts on the jumper hose from the intermediate pipe 13 irrespective of the position of the body 5.

Thus no bending moments are transferred from the body 5 to the platform 2 neither through the hanger 11 nor the jumper hose 8, and thus no bending moments act on the riser 1.

Fig. 5 illustrates another embodiment of the suspension device. This embodiment is similar to the embodiment in fig. 4, except that the jumper hose 8 is arranged in a helix around the hanger 11, in which helix the upper part is formed by a piece of pipe 33 forming a part of the piping 4. Further the platforms hanger attachment 12 is supported by an attachment bracket 26 which in turn is supported by the piece of pipe 33.

It should be obvious that the suspension device depicted in fig. 5 functions in the same way as the suspension device in fig. 4, which is discussed above. It should also be obvious that the suspension device in fig. 2 will function similarly to the suspension devices in fig. 3-5, and s separate discussion of the how the suspension device in fig. 2 functions is therefore not included.

Fig. 6 illustrates an application of the suspension device in closer detail than in fig. 1. Three suspension devices are suspended from hanger attachments 12 supported by girders 25 which supports the deck of a platform (not illustrated). Fig. 6 illustrate two features which are not illustrated in the above figures.

Each hanger 11 in fig. 6 consists of a swivel 18 and a chain link 27, 27' on each side of the swivel, for connecting the swivel 18 to the body's 5 hanger attachment 7 and the platform's hanger attachment 12. The swivel enables a rotation of the hanger 11 around a longitudinal direction, i.e. around the above discussed notional line between the body's hanger attachment 7 and the platform's hanger attachment 12. Consequently a relative rotation between the body 5 and the girder 25, i.e. a relative rotation between the riser 1 and the platform, around this longitudinal direction, will cause the swivel 18 to rotate, without transferring any torque between the body 5 and the platform. The swivel 18 thereby provides a torque-free hanger 11, and no torque acts on the riser 1. Bending movements will be absorbed

by movements in the chain links 27, 27', similarly to a rotation of the pivot joints 19, 19' discussed with reference to fig. 4.

The suspension device in fig. 6 also illustrates that the intermediate pipe 13 comprises a connection 15 for a pig launcher 28, which is used for pigging the riser 1. When pigging the riser, the hatch 29 is opened and a pig is placed in the pig launcher 28. Then the pig is launched by supplying pressurised fluid on the upper side of the pig, a valve (not illustrated) between the pig launcher 28 and the intermediate pipe 13 is opened, and the pig is forced down the riser 1.

In other respects the suspension devices in fig. 6 are similar to the suspension devices discussed above.

Fig. 7 illustrates another application of the suspension device according to the invention. Five suspension devices suspend risers 1 extending from the sea floor to a floating structure 2 formed by a floating subsea buoy. This buoy is located between the sea floor and a not illustrated platform above the sea surface. The risers 1 are connected to flexible piping 4 which in turn is connected to the platform above the sea surface. The suspension devices are suspended from attachments 12, which in turn are supported from a bracket 26 which is welded to the buoy.

Fig. 8 illustrates a further suspension device according to the invention. This embodiment comprises an intermediate pipe 13 which is secured by securing means 6, like in fig. 3. Fig. 8 also illustrates securing means 6' for the riser end 3, like in fig. 2. The embodiment in fig. 8 is thus something between the embodiments in fig. 2 and fig. 3, and functions similarly.

Fig. 9 illustrates a further suspension device according to the invention. In this embodiment the intermediate pipe 13 is integral with the body 5, or more precisely, the body 5 is formed by the intermediate pipe 13. One branch 13' of the intermediate pipe is provided with a jumper hose connection 14, and another branch 13" is provided with a connection 15 for a combined pig launcher/receiver. The connection 15 is connected to a pig launcher pipe 31, shown in dashed lines, which is connected to the pig launcher/receiver 28 with the hatch 29, also shown in dashed lines. The intermediate pipe 13" and the pig launcher pipe 31 is curved, and the pig launcher/receiver 28 is thereby located horizontally, which is favourable to enable both launching and receiving of pigs.

Fig. 9 also illustrates a pipe swivel 16 between the riser end connection 9 and the intermediate pipe 13, which allows a relative rotation between the riser 1 and the

intermediate pipe 13 around the longitudinal direction of the riser 1, without generating any torque in the riser 1.

An attachment bracket 30 is welded to the two branches 13' and 13" of the intermediate pipe, and is provided with an eye 7 which forms a hanger attachment. A moment-free hanger 11, which is formed by a chain 17, connects the hanger attachment 7 and a hanger attachment 12 on a girder 25 which supports a not illustrated deck of a platform 2.

The jumper hose can be a commercially available hose made of rubber reinforced with steel rings. The other items can be made of steel.

The above figures illustrate various designs of the suspension device according to the invention. Further variations are, however, conceivable, e.g. with respect to the hanger 11, which may consist of various combinations of known mechanical elements providing a moment-free hanger, and preferably also a torque-free hanger, e.g. a universal joint. The illustrated hangers 11 have fixed lengths. It is, however, possible also to provide the hanger with a dampening mechanism in order to dampen variable tension loads, e.g. a spring or a hydraulically actuated dampening element.

PATENT CLAIMS

1. A suspension device for a riser (1), for connecting the riser (1) to piping (4) on a fixed or floating structure (2), characterized by comprising

a body (5) with securing means (6) for the riser end (3), the riser end (3) being secured by the securing means (6); and a hanger attachment (7),

an essentially flexible jumper hose (8) extending from a riser end connection (9) to a piping connection (10) on the fixed or floating structure (2), and

an essentially moment-free hanger (11) extending from the body's hanger attachment (7) to a hanger attachment (12) on the fixed or floating structure (2).

2. A suspension device for a riser (1), for connecting the riser (1) to piping (4) on a fixed or floating structure (2), characterized by comprising

an intermediate pipe (13) extending from a riser end connection (9) and having a jumper hose connection (14),

a body (5) with securing means (6) for the intermediate pipe (13), the intermediate pipe (13) being secured by the securing means (6); and a hanger attachment (7),

an essentially flexible jumper hose (8) extending from the jumper hose connection (14) of the intermediate pipe (13) to a piping connection (10) on the fixed or floating structure (2), and

an essentially moment-free hanger (11) extending from the body's hanger attachment (7) to a hanger attachment (12) on the fixed or floating structure (2).

3. A suspension device according to claim 2, characterized in that the body (5) comprises securing means (6') for the riser end (3).

4. A suspension device according to claim 2 or 3, characterized in that the intermediate pipe (13) comprises a connection (15) for a pig launcher/receiver (28).

5. A suspension device according to any of the claims 2-4, characterized in that the intermediate pipe (13) is integral with the body (5).

6. A suspension device according to any of the claims 2-5, characterized in that the body (5) is formed by the intermediate pipe (13).

7. A suspension device according to any of the claims 2-6, characterized by a pipe swivel (16) between the riser end connection (9) and the intermediate pipe (13).

8. A suspension device according to any of the preceding claims, characterized in that the hanger (11) has a fixed length.

9. A suspension device according to any of the preceding claims, characterized in that the hanger (11) is essentially torque-free.

10. A suspension device according to any of the preceding claims, characterized in that the hanger (11) is formed by a chain (17).

11. A suspension device according to any of the preceding claims, characterized in that the hanger (11) comprises a swivel (18).

12. A suspension device according to any of the preceding claims, characterized in that the hanger (11) comprises pivot joints (19, 19').

13. A suspension device according to claim 12, characterized in that the hanger comprises two pivot joints (19, 19') having perpendicular rotational axes (20, 20').

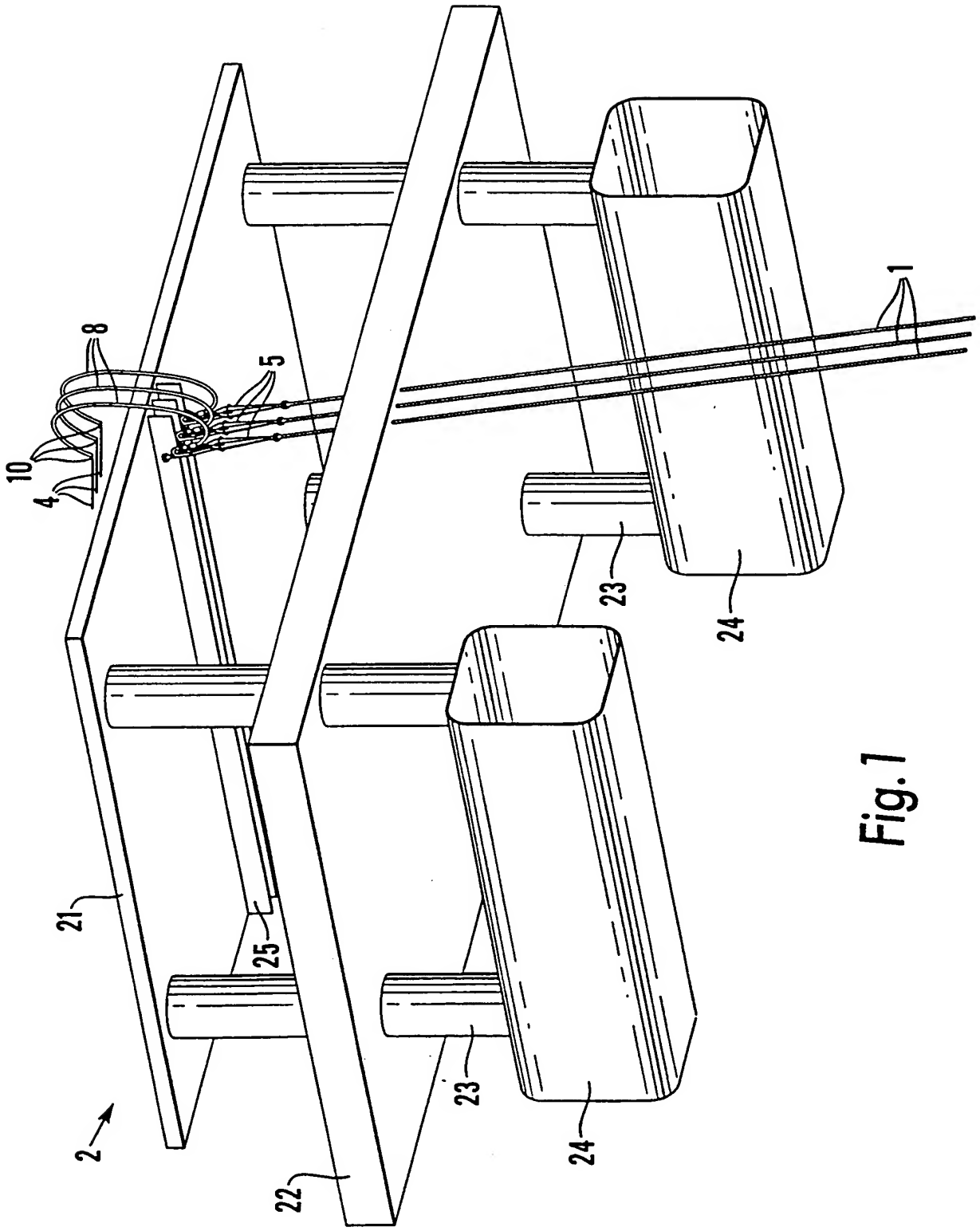

Fig. 1

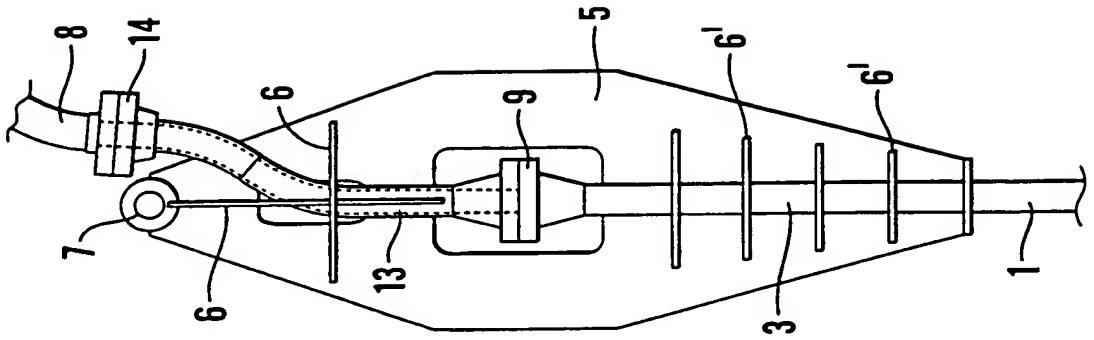

Fig.8

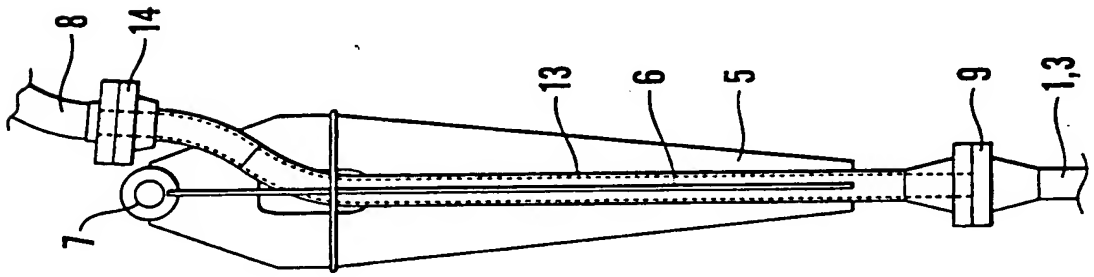

Fig.3

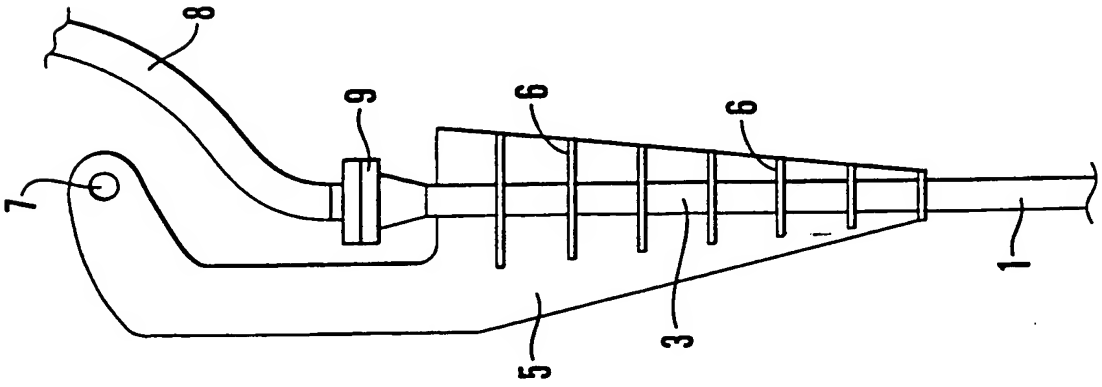

Fig.2

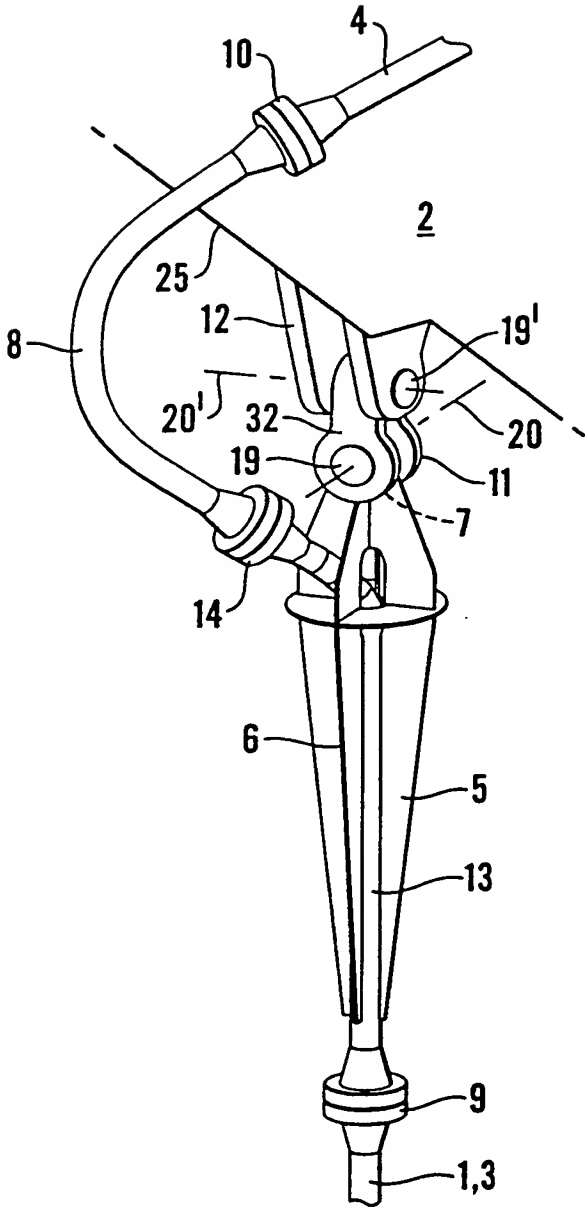

Fig.4

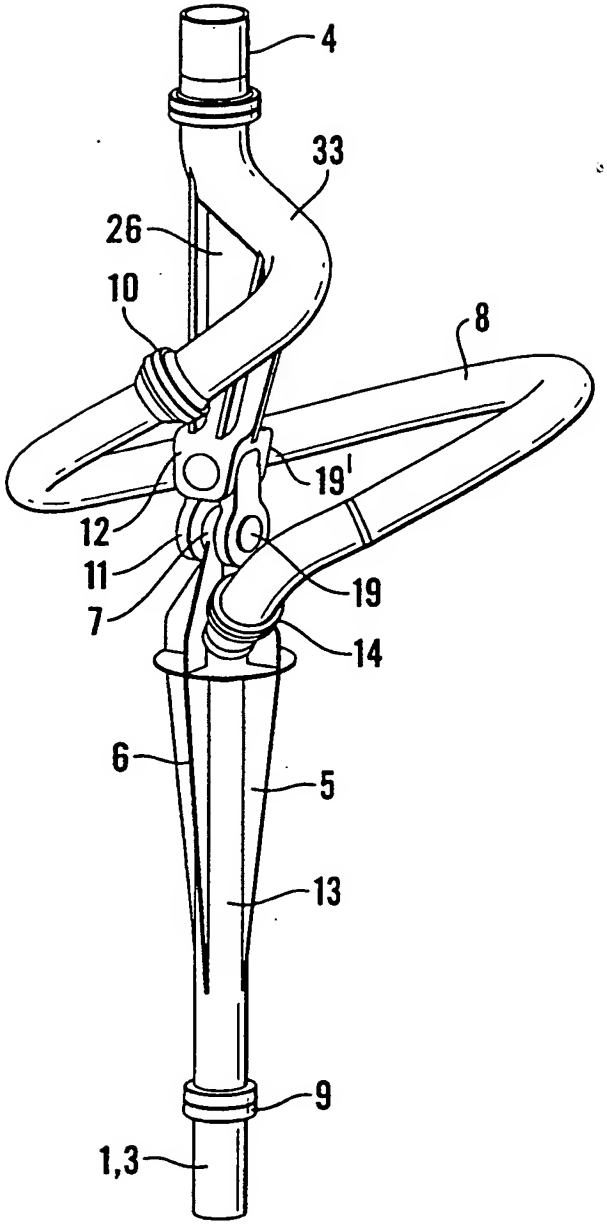

Fig.5

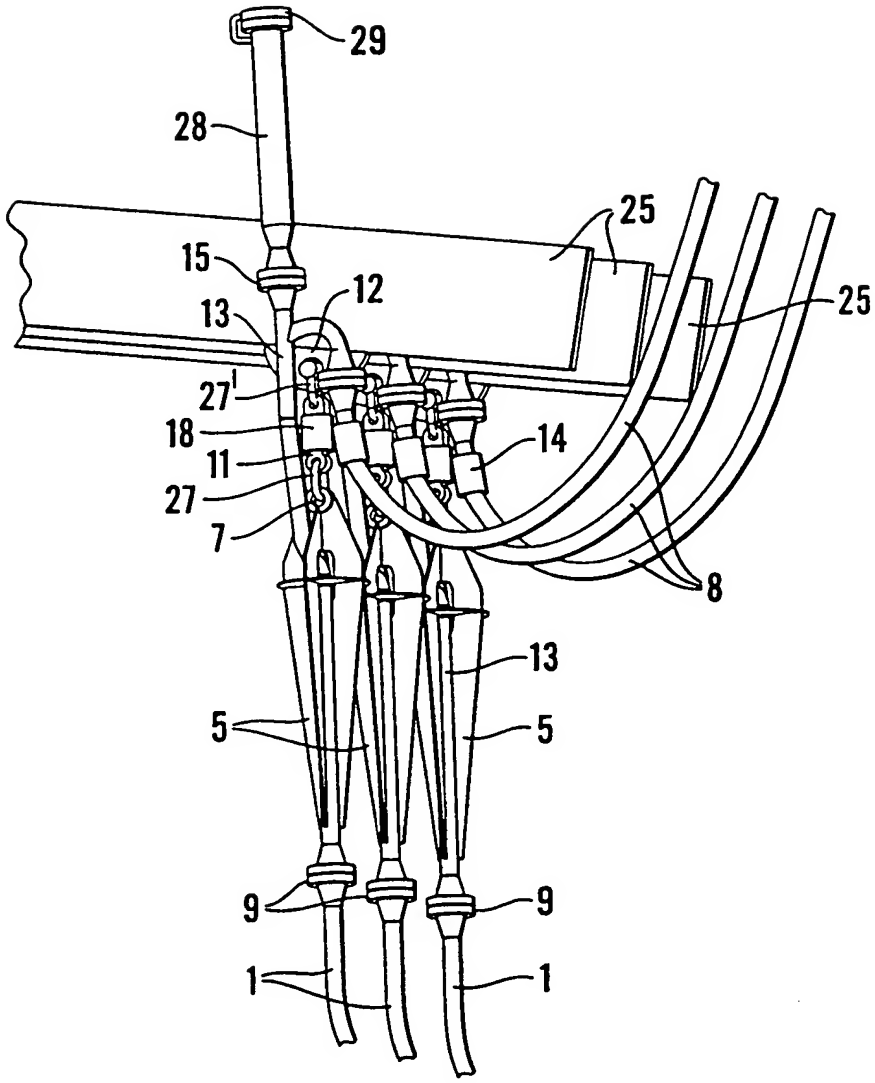

Fig.6

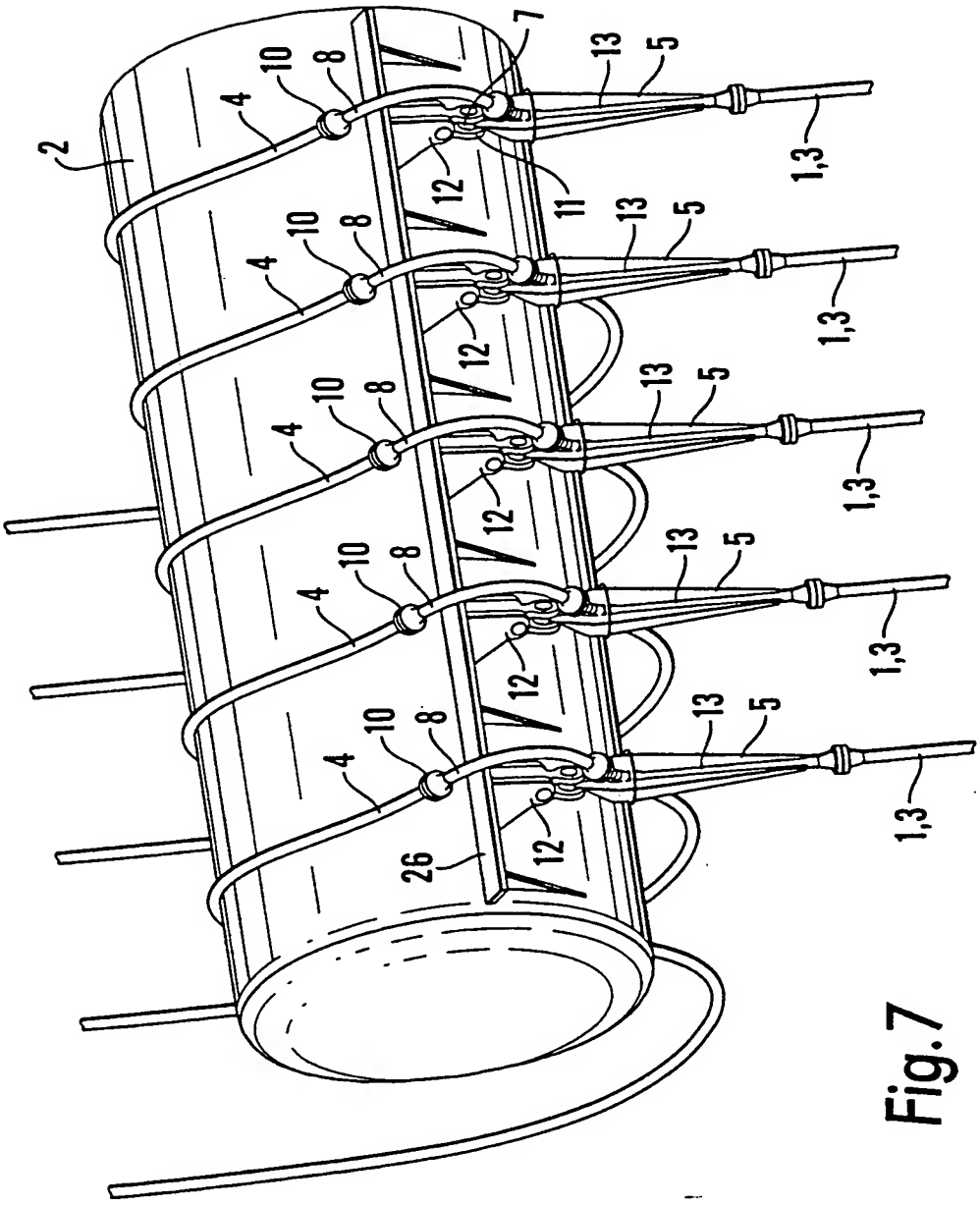

Fig.7

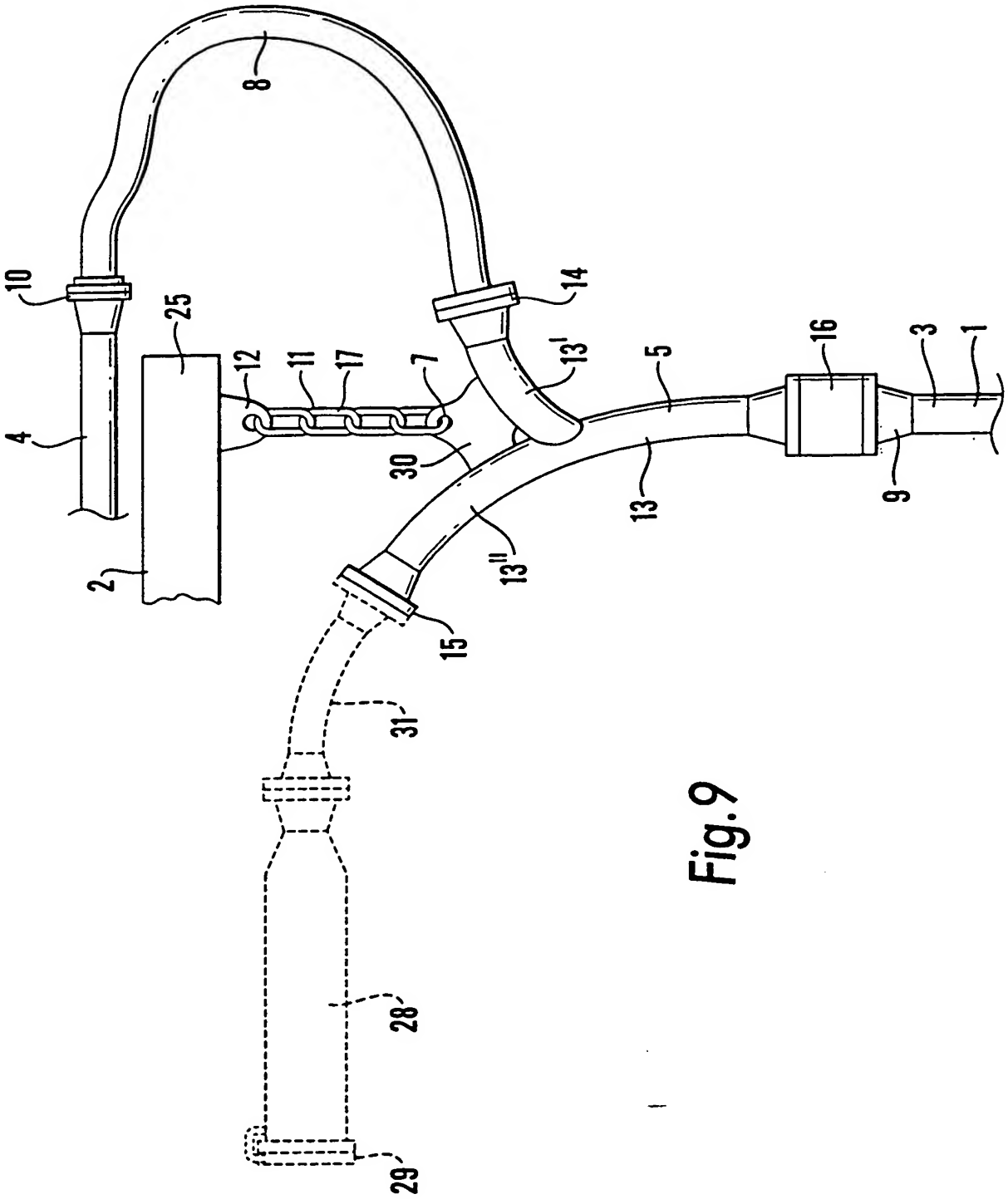

Fig.9

INTERNATIONAL SEARCH REPORT

Inter. ...nal Application No
PCT/NO 00/00357

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B63B21/50 E21B17/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B63B E21B B67D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 295 408 A (MOBIL OIL CORP) 29 May 1996 (1996-05-29) figures 4,5	
A,P	WO 00 31372 A (FOSTER WHEELER ENERGY LTD) 2 June 2000 (2000-06-02)	
A	US 5 927 902 A (SVEEN DAGFINN ET AL) 27 July 1999 (1999-07-27)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2001	09. 04 2001

Name and mailing address of the ISA	Authorized officer
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